

# Waste Water Reclamation and Re-use

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# Topics of Discussion

- Introduction
- Types of Waste
- Problems Involved in Wastewater Treatment
- Treatment Methods
- Uses of Reclaimed Water



# Introduction

- Sources of Wastewater
- Quantity Generated
- Typical Characteristics of Wastewater



# Types of Waste in Water Generated

- Inorganic Waste
  - Grit, Gravel, Sand
  - Dissolved Inorganics
  - Heavy Metals
  
- Organic Waste
  - Chemical Waste
  - BOD
  - COD
  - Fats, Oils, Grease
  
- Biological Waste
  - Test Animal Remains
  - Plant Clean up

# Problems Involved with Wastewater Applications

- Diversity of Composition
- Diversity of Characteristics
- Variable Amounts of Flow
- High BOD
- Variable pH



# Treatment Methods

- Physical Treatment
- Chemical Treatment
- Thermal Treatment
- Biological Treatment



# Physical Treatment

- Sedimentation
  - Suspended particles are allowed to settle and supernatant removed
- Filtration or Ultrafiltration
  - Used to remove particulate contaminants
- Activated Carbon Adsorption
  - Used for the removal of organic contaminants (COD)
- Reverse Osmosis
  - Used for the removal of dissolved solids
- Ion Exchange
  - Used for the removal of trace metals, nitrates, fluorides etc.

# Chemical Treatment

## ➤ Flocculation

- Gathering of fine particulate that allows them to settle

## ➤ Neutralization

- A process utilized to prevent excessively acidic or alkaline wastes from being discharged

## ➤ Reduction

- Treatment to reduce the oxidant to less noxious materials

## ➤ Precipitation

- pH induced phase change from a dissolved ion to a precipitated particulate



# Thermal Treatment

## ➤ Calcination

- Heating a waste to a high temperature to oxidize organic matter

## ➤ Incineration

- Controlled heating processes to convert a waste to less bulky, less toxic or less noxious

## ➤ Pyrolysis

- Thermal decomposition of a waste at high temperatures in the absence of oxygen



# Biological Treatment

- Used to remove biodegradable organic matter
- Micro-organisms convert organics into:
  - $\text{CO}_2$  and  $\text{H}_2\text{O}$  (aerobic)
  - $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{H}_2\text{O}$  (anaerobic)
- Activated Sludge
  - Process in which microorganisms are continuously circulated and contacted with organic waste in the presence of oxygen
- Aerated Lagoons
  - A basin in which organic waste is stabilized by a dispersed biological growth in the presence of oxygen
- Waste Stabilization Ponds
  - Large shallow basins that store wastewater and purify under natural conditions in the presence of algae
- Trickling Filters
  - Artificial beds of rock or other porous media through which aqueous organic waste is percolated and in contact with biological growth and oxygen
- Anaerobic Digestion
  - Closed tanks operated in the absence of oxygen



# Different Types of Biological Treatment and their Efficiencies

TECHNOLOGY	BOD REDUCTION, %
➤ Aerobic Treatment <ul style="list-style-type: none"><li>• Activated Sludge</li><li>• Aerobic Fixed Growth Systems</li></ul>	56 - 96
➤ Anaerobic Digestion with Controlled Aeration	80
➤ Anaerobic Digestion	60 - 90
➤ Trickling Filters	60 - 98
➤ Biofiltration <ul style="list-style-type: none"><li>• (consisting of aerator, clarifier and filters)</li></ul>	>90
➤ Advanced Biological Treatment <ul style="list-style-type: none"><li>• (includes ammonia reduction and nitrification)</li></ul>	90

# Where can the Reclaimed Water be Re-used?

- In order to determine which technologies to use, the reclaimed water can be re-used, we must evaluate the potential areas the water can used.
- Are there environmental constraints?
- Are there mechanical constraints?
  - Corrosion
  - Scaling
  - Biological Growth
- Are there cost constraints?
  - Chemical Costs
  - Capital Costs



# Potential Areas for Reuse

- Irrigation
  - Landscaping
  - Edible Crops
- Boiler Feed Water
- Cooling Tower Make-up
- Utility Water
- Process Water

# Determining the Correct Treatment Path

- We need to first understand the source and quality of the water to be re-used.
- List all of the potential sources of wastewater that can be re-used?
- Is the water from a single source or multiple sources?
- What is the quantity and quality of the wastewater from each source?
- What is the variability of the quantity and quality of the wastewater source?

# Selecting the Proper Treatment Path

- Wastewater re-use technologies are only as good as the selected wastewater pretreatment systems in front of them.
- Wastewater re-use technologies are prone to
  - Scale formation
  - Oil fouling
  - Biological fouling
- Poorly designed or applied wastewater pre-treatment can lead to catastrophic failure of the re-use technologies. Always design the wastewater pre-treatment to conservatively to work under the most difficult conditions



# Selecting the Proper Treatment Path (continued)

- **Piloting and Bench Testing**
  - When considering wastewater reclamation projects, bench testing and field pilot studies provide significant benefits
- **Bench Testing**
  - Bench tests can provide a quick understanding if the wastewater has the potential for re-use
- **Pilot Studies**
  - Field pilot studies, normally performed after bench studies, can operate under “normal” conditions. Experiencing daily variation in wastewater feed conditions and actual on site environmental conditions. Effects of long term operation on O&M of reuse components can also be determined.



# Typical Wastewater Reclamation

